RETURN

(93)

To an order of the house of commons, dated the 18th November, 1909, showing the number of fatal accidents resulting from the use of explosives in the construction of railways and other public works in Canada, reported to either the Department of Railways and Canals, the Department of Public Works or the National Transcontinental Railway Commissioners, within the past three years; the nature of investigation, if held, after each accident; and what precautions have been taken to prevent or minimize the number of accidents from the use of explosives on construction work in Canada under control of Government Officials.

CHAS. MURPHY,
Secretary of State.

Return of Fatal Accidents resulting from use of Explosives in Construction of National Transcontinental Railway.

District.	Year.	Number.	Nature of Investigation.
"A"	1907	None.	
	1908	2	Investigation by coroner in all cases.
	1909	9	" " "
"B"	1907	3	" " "
	1908	12	" " "
	1909	2	" " "
"C" and "D"		None.	
"E"	1907 and 1908	None.	Coroner's inquests were held in seven of these and decided no inquest was necessary in the other two.
	1909	9	
"F"	1906 and 1907	13	Inquests held in all these cases.
	1907 and 1908	35	" " "
	1908	27	" " "
	1909	2	" " "
	Total ...	114	

The Commissioners of the Transcontinental also sent Dr. J. T. Donald an expert analyst and assayist to investigate and report on the use and quality of the explosives employed in District 'F.' He reported the principal causes of the accidents as careless or ignorant handling of the explosives. He stated that but little fault could be found with the quality of the explosives. Copy of report attached.

When accidents occurred report was at once sent by the Resident Engineer to the District Engineer giving name of party, probable cause of accident. The Contractor also invariably notified the Coroner for the District who looked into each case and held an inquiry if he deemed necessary. In the Province of Quebec inquests were held by the Coroner in all cases.

THE COMMISSIONERS OF THE TRANSCONTINENTAL RAILWAY.

Notice to Contractors and Subcontractors on the National Transcontinental Railway.

Your attention is called to the following abstract from Gillette's 'Rock Excavation,' published by M. C. Clark, of New York, and you are urgently requested to give as much publicity to this as possible among men in your employment handling explosives, in the hope that by so doing the danger may be minimized.

HUGH D. LUMSDEN,
Chief Engineer.

'Familiarity breeds contempt for the danger ever present in using dynamite, and the Manager of blasting operations must not rely merely upon orders to the men not to do-this or that, but must be vigilant to observe whether orders are obeyed or ignored. Instant discharge of an employee should be the punishment for the slightest infraction of rules governing the use of explosives.

'Dynamite can be ignited with a match, and will usually burn up without exploding, provided that there are only a few sticks not confined in any way. This fact has much to do with breeding contempt for the danger attending using.

'When the paper cartridges feel greasy it is due to leakage of nitroglycerine. When a whittish cust, or efforescence, is found on the outside of a dynamite cartridge it indicates that the dynamite has been stored in a damp place, or that the 'dope' originally contained an excess of moisture. In either case the crust is nitrate of soda, that has dissolved out, and such dynamite is almost certain to leak nitroglycerine. It is unreliable, dangerous to handle, and should be destroyed at once. Greenish stains inside the cartridge indicate that the nitroglycerine is decomposing and is dangerous.

'When frozen it cannot be exploded by the ordinary caps used in blasting; nevertheless in its frozen state it is exceedingly sensitive to friction or to any breaking or cutting of the frozen cartridge. The Annual Report for 1898, of the Inspectors of Explosives of Great Britain, states that in that year there were eighty-one accidents in thawing dynamite, resulting in killing sixty-eight men and injuring ninety-seven. Accidents from other causes were 194 in number, resulting in the killing of 52 men and the injury of 216. This shows in a striking manner how dangerous a process the thawing of dynamite is. Dynamite should never be thawed by plunging the sticks into warm water. The only methods of thawing dynamite permitted by the Municipal Explosives Commission in New York City are thawing with manure, and thawing in a dry chamber heated by hot water entirely separate from the fire that heats the water.'

'The plan of placing a can of hot water in a small thawing magazine is one of the safest methods that can be adopted.'

'Dynamite that has been frozen and thawed a number of times often leaks, although before the freezing and thawing it did not leak at all. Hence a few sticks should be frozen and thawed three successive times and then tested for leakiness on brown paper.

'Long continued high temperature will develop leakiness in a poor quality of dynamite. Hence a few samples should be kept at a temperature of 85° to 90° F. for six consecutive days and nights and then tested for leakiness on brown paper.

'In charging: Dynamite should never be rammed, but merely pressed home; and a steel or iron tamping rod should never be used for that purpose. Remember that a drill hole tapers towards the bottom and the cartridges should never be so large as to require forcing to get them to the bottom. A cap should never be crimped onto the fuse with anything but a 'crimper' made for the purpose. When using a battery the final connection should not be made until all the workmen are at a safe distance.

'A miss-fire when an electric battery is used may be due to any one of several causes: (a) A blasting cap may be defective, due to the fact that water has penetrated the cap or to the fact that the platinum bridge in the cap has become unsoldered.

(b) Short-circuiting may be caused by a half-hitch taken with the fuse wire around the primer (which is a poor but common practice), which may have broken the insulation so as to permit the electric current to pass from one wire to the other without passing through the cap, but in this case charges in all other holes of the series will explode. (c) A defective splice in the connecting wires may have broken the circuit. (d) A fuse wire may have been broken in the process of tamping. (e)The battery may be overloaded. This last cause is one of the most common causes of miss-firing.

'Never load a battery up to its limit, but have a good margin of surety that it will explode all the caps in the series. Saunders is authority for the statement that a weak battery may explode part of the caps and leave the rest unexploded, due to variations in the resistance of the platinum bridges in the caps. In case of a miss-fire no one should approach the holes for half an hour if electric firing is used, and not for several hours if fuse firing is used.

'After waiting some time it may be necessary to remove part of the tamping in the hole and put down another primer. This is a dangerous operation at best, and if black powder is used a copper or wooden (never steel) spoon should be used in removing the tamping. In any case never remove the tamping entirely, but leave 3 or 4 inches of the cushion tamping above the charge in place. Then place several sticks of dynamite and a primer on top of the first charge and fire again.'

'The New York City rules forbid removing tamping at all, and require that a new hole shall be drilled not closer than 12 inches to the old one. Whenever an explosion fails to carry away the rock clear to the bottom of a drill hole, it is forbidden to begin drilling in the bottom of the old drill hole, as part of the former charge may remain unexploded in the bottom of the old hole and explode under the blows of the drill.'

'I question whether it is always safe practice to drill a new hole within a few inches of the old hole, hoping to be able to explode the charge in the old hole by a blast in the new hole. A safer practice is to drill the new hole several feet from the old hole and to a depth that will bring the bottom of the new hole on a level with the top of the charge in the old hole. Then upon blasting the new hole the shattered rock around the old hole may be removed, the dynamite exposed, a cap inserted and fired.'

'Don't thaw dynamite on stones.'

'Don't thaw dynamite in front of a kitchen fire or in an oven.'

'Don't thaw dynamite on a shovel.'

'Don't thaw dynamite in a hot water thawer placed on blacksmith's fire.

'Don't thaw dynamite with a candle.

'Don't rub cartridges in hands to complete thawing.'

'Don't leave dynamite in pockets of trousers and hang before a fire to dry.'

'Don't thaw dynamite in water over a fire.'

'A man laid some sticks of 75 per cent dynamite upon a flat stone which had previously been heated by placing hot coals upon it. While in the act of picking up a handful of thawed sticks he was blown to atoms. He was using this method, contrary to orders, because he had thawed dynamite all his life that way.'

INVESTIGATION AS TO USE AND QUALITY OF THE EXPLOSIVES USED ON T. C. RY. IN VICINITY OF KENORA.

The matter will be treated under the following heads:—

1. Districts covered by investigation.
2. Mode of storage and thawing of explosives.
3. Handling in blasting.
4. Sampling and analysis of explosives used.
5. Probable cause of accidents.
6. Prevention of accidents.

7. Appendices.
A. Map showing points visited.
B. Photos of magazines and thaw-houses.
C. Analysis of explosives.
D. Directions for handling explosives.
E. Accident causing death of Andreas Rasmussen.

The investigation was carried out by the undersigned, and his assistant, Mr. Normand Holland, F.C.S., February 11th-22nd, 1909.

1. The original intention was to confine the examination to the district lying north of Kenora, and on either side of Residency 30.

An accident occurring in this district on January 4th had caused the death of one Andreas Rasmussen, and the jury dealing with this death had affirmed that an enquiry was desirable.

But as only one brand of explosives was found in all the camps visited in this district. it was considered desirable that the examination be continued on another portion of the line.

After consultation with Mr. J. F. McIntosh, the Engineer who accompanied us, it was decided that portions of the line east and west of Contractor Parsons' headquarters on Canon lake should be visited. The investigation therefore covered portions of the line north of Kenora and north of Vermilion—points some 55 miles apart. On the accompanying map kindly supplied by Mr. McIntosh, points visited, cuts, tunnels, burrows, &c., are marked in red.

11 A. The magazines or storage houses at the various camps are log structures of various sizes, a common size being about 12 to 14 feet square. These structures are at reasonable distances from other buildings and appear well suited for the purpose. Some were locked and others not. The majority of these had no sign to indicate their purpose or to warn of danger. The supply of explosives in the store houses in the Kenora portion was small, about 70 cases of 50 pounds dynamite and 125 cannisters 25 pounds each black powder, being the largest quantity found.

II.—THAWING DYNAMITE.

Small huts at some distance from the store houses are in general use. These thaw-houses are log structures well plastered between the logs and with a tight roof. A comparatively large stove occupies the centre. Shelves along the walls serve to carry the sticks of dynamite. The floor is usually saw-dust, presumably to prevent friction on the spilt materials. The stove is close and well jointed and not likely to permit escape of sparks. Heavy fires are kept in these stoves, and the interior of the hut becomes very warm, a temperature of considerably over 100° F. being noted more than once. The wood in the walls and roofs becomes very dry and inflamable. As a consequence a number of these houses have taken fire, in one case with fatal results. These thaw-houses seem to be well adapted for heavy work where a large quantity of explosives is used. The fact that we could learn of only one instance where there had been loss of life in a thaw-house, speaks well for this mode of thawing, considering the large quantity of explosives used.

Another common method of thawing where only a small quantity is used at a time, is to immerse the sticks in hot water. A fire is built in the open, a tin can of water is heated, this is removed from the fire and the dynamite is put in. The same water is heated again and again. We are not able to learn of any accidents from this method of thawing.

III.—HANDLING IN BLASTING.

The holes are loaded and fired in the usual way either by lighting the fuse by means of a brand, or by one or other of the well known forms of battery. The loading

as a rule seemed to receive less care and attention than it deserved. The cartridges were roughly pushed into the holes and rammed. Moreover, the dynamite was frequently spilled or even poured out of the cartridges and left lying about the surface near the hole. This matter is further dealt with under the next heading.

Most of the batteries examined were satisfactory, but in one or two cases required much persuasion to bring about the firing of even a few holes, and such weak batteries may be the cause of mis-fires at times.

IV.—SAMPLING EXPLOSIVES AND TESTING SAME.

The following Explosives were met with during our Investigation.

1. Black powder, Nos. 1, 2 and 3.
2. Dynamite, 2 grades, viz.: 50 per cent and 60 per cent nitroglycerine, were mostly in evidence. A small quantity of the 40 per cent grade was found.
3. A composite explosive consisting of black powder and nitroglycerine in admixture.
4. A chlorate powder known as Verite.

The physical condition of the 40 per cent dynamite was not perfect. In all brands of this grade, there was more or less deterioration evidenced by the presence of nitrate of soda, crystalized on the outside of the cartridges and more or less 'leakage' of the nitroglycerine. In only one instance was the deterioration at all serious. This was a lot of five cases 'Standard' which had been received by McRea & Courtenay only a short time prior to our inspection. The Contractor, as soon as his attention was called to the matter ordered the destruction of what was left of the five cases. Later investigation showed that these faulty cases were from a lot that had been in the manufacturers' magazine for a long time. There is reason to believe they had been sent out on the supposition that they were in normal condition. The manufacturer was at once advised of the unsatisfactory condition of this lot. Except in the case of this 40 per cent dynamite, the physical condition of all the explosives seen, was highly satisfactory.

A chemical examination of a series of samples collected at various points throughout the area visited, has been made. If we except the five cases of 40 per cent goods, all of the samples of dynamite are fully up to the reputed percentage of nitroglycerine. The latter is of satisfactory degree of purity and no undesirable ingredients are present. Some of the samples, however, show a deficiency in Antacid.

The black powder samples are normal and in every way satisfactory.

The chlorite explosive Verite seems satisfactory notwithstanding the prejudice that in certain quarters exists against chlorate. Those who had used it declared it to be very satisfactory both in efficiency and safety.

In appendix C. the general composition of representative samples is shown.

V.—PROBABLE CAUSE OF ACCIDENTS.

Observation and enquiry leads to the belief that accidents are due to lack of knowledge of the properties of the explosives under varying conditions. This lack of knowledge leads to what is commonly spoken of as 'careless' handling. It would probably be more correct to call it ignorant handling. Such handling was in evidence along two lines, and there is reason to believe that along these two lines lies the cause of a large majority of the accidents.

A. In loading the holes with dynamite, there is not sufficient care in the disposal of the explosive. Instead of the careful placing of the explosive in the lower part of the hole it is at times spilt about the mouth of the hole and even poured from the shell as though it were sand. The result is that, in case of a mis-fire and attempt to clean

out the hole, some of this scattered explosive which had become mixed with the tamping is exploded by a blow from the drill and there is an accident. At other times, cartridges are spilt along the sides and then forced down into the holes. More or less of the explosive is thus forced into the joints and fractures which abound in the rock and form a menace to the workers who may have to clean out a sprung hole or handle the muck. The death of Andreas Rasmussen was probably caused by dynamite scattered in this way. See Appendix 'E.'

E. Premature discharge of a hole is frequently the cause of accidents. In such cases, it is generally difficult to get any reliable information as to procedure preceding the explosion. Usually those who are sufficiently near to see and know what was being done perish. There is good reason to believe that not a few of the premature discharges are traceable to imperfect or incomplete thawing of dynamite, or to incipient freezing. While on the boundary line between the liquid and the solid or frozen state, dynamite appears to be very sensitive to shock. A tamping that would produce no unsatisfactory results when the nitroglycerine is in ordinary liquid condition, may produce disastrous results when it is in the unstable condition of transition between liquid and solid states.

If proper attention be given to these two points, viz: careful disposition of the explosive in charging a hole and the use of dynamite only when its nitroglycerine is undoubtedly in normal liquid condition, the number of accidents would be very largely reduced indeed.

VI.—PREVENTION OF ACCIDENTS.

As already indicated, there is but little fault to be found with the explosives met with in our investigation. At the same time it is desiravle that manufacturers be asked to consider the following points which apply to the three brands of dynamite. Attention to these will widen the margin of safety in handling the explosives.

A. In some of the dynamite examined, the material as a whole was but faintly acid, yet portions of a cartridge would be found markedly acid in reaction. Every effort should be made to have any antacid used, thoroughly incorporated and the whole of uniform composition.

B. In many cases, the cartridges are too full. So much so that at one end, portions of the explosives extend beyond the paper shell. When such is the case, it is difficult to avoid spilling, with its attendant dangers. The dynamite should be completely closed in by the paper shell.

C. Any dynamite that has been stored for a long time should be carefully inspected and not sent out or used unless found to be in perfect condition.

None of the 40 per cent dynamite seen in the course of our investigation was in perfect condition. But little of this grade is used, and as a consequence, parcels of it are likely to be held in magazine for some considerable time. This may mean numerous freezings and thawing, and these are very likely to lead to deterioration and unreliability.

If those who handle the explosives would give heed to the 'Notice to Contractors and Sub-Contractors' issued by the Commissioners (Appendix D) there would be but very few accidents. The same may be said of the admirable sheets of directions found in every box of explosives sent out by two of the large Canadian manufacturers (Appendix D). It is doubtful if many of the men ever see these directions. Moreover, they are in languages (English and French) with which the majority of the men on the construction work have but a very limited acquaintance.

NOTICE TO CONTRACTORS AND SUB-CONTRACTORS.

The notice to Contractors and Sub-Contractors sent out by the Commissioners, contains one fruitful sentence that suggets what seems to be the best means of preventing these accidents with their deplorable loss of life, 'The manager of blasting

operations must not rely upon orders to the men to do this or that, but must be vigilant to observe whether orders are obeyed or ignored.'

Inspectoral and educational work along the lines followed by the Dominion and Ontario governments in other connections, offer in the opinion of the writer the best means of preventing accidents from explosives.

The Dominion government in 1907 placed Inspectors in the Canadian Packing Houses to protect the public against diseased and unwholesome meat and meat products.

The Ontario government has each summer for a number of years sent out trained men into mining districts of the province, who have gathered together the miners and given them instruction on rocks and minerals.

The writer would suggest the appointment of a few men, who might be known as inspectors of explosives (Great Britain has such officials). These men should be furnished with authority to visit factories and thoroughly inspect all parts of the process of manufacture, sampling where considered necessary or desirable. They should have authority to inspect stocks in magazines of manufacturers and contractors, and to order the destruction of any explosives showing deterioriation from storage or otherwise. It should be part of their duty to move about, where construction work is going on, to inspect the explosives, fuses, batteries, &c. They should gather the men at the various camps and explain to them (through an interpreter if necessary) and by means of brief printed directions in the native tongues of the various workers. They should mix with the gangs at work, noting their mode of handling explosives, pointing out mistakes that may come under their notice and commending good practice where met with.

It is believed manufacturers and contractors alike would welcome the appointment of such officials, and would facilitate the performance of their duties.

The appointment of a few men with proper qualifications for the work, viz: knowledge of the subject, ability to interest the workers, and possessed of the desire to save life, would be the very best means to prevent accidents and save valuable life.

The writer would strongly urge the serious consideration of this proposal.

J. T. DONALD.

Montreal, 5th March, 1909.

Appendix C 1.

FOUR SAMPLES DYNAMITE.

—	I.	II.	III.	IV.
Reaction	Acid.	Acid.	Acid.	Alkaline.
Starch iodine test	Satisfactory.	Satisfactory.	Satisfactory.	Satisfactory.
	%	%	%	%
Moisture	1·85	1·88	2·22	2·25
Nitro-glycerine	60·10	52·05	60·89	51·72
Soda-nitrate	16·28	30·19	18·71	30·90
Wood meal, &c	21·77	15·88	18·18	15·13
	100·00	100·00	100·00	100·00

No. 1—"Standard" ..... 60% dynamite. McRae & Courtenay's camps.
No. 2— " ..... 50% " " "
No. 3—"Ontario" ..... 60% " Magazine at Kenora.
No. 4—"Hamilton" ..... 50% " Tunnel Parson's contract.

J. T. DONALD.

Montreal, March 5, 1909.

Appendix C 2.

THREE SAMPLES BLACK POWDER.

—	I.	II.	III.
	%	%	%
Moisture	0·88	1·78	0·70
Pot. nitrate	74·46	70·47	75·21
Sulphur	9 78	10·45	9·35
Charcoal, &c.	14·90	17·30	14·74

No. 1—Stardard Explosives, No. 1 powder ..... McCaffrey's camp 7.
No. 2—Hamilton Powder Company, No. 2 powder..... Parson's camp 1.
No. 3—Standard Explosives, No. 3 powder..... McCaffrey's camp 7.

J. T. DONALD.

Montreal, March 5, 1909.

Appendix 'E.'

ANDREAS RASMUSSEN.

The facts of the case appear to be as follows:—A hole in cut No. 886 near Grindstone lake was sprung. This man was cleaning out the hole preparatory to reloading; an unexpected explosion occurred. Although it was on a comparatively small scale Rasmussen was struck on the head and killed. There can be no reasonable doubt that his drill struck some dynamite that had become mixed with the tamping, or had found a lodging place in some of the joints or crevices of the rock, as explained in section. Any dynamite struck in this way is, of course, likely to explode.

The foreman, George Doherty, who, before the coroner's jury that disposed the case, gave evidence that lead the jury to find the standard powder is an 'uncertain and dangerous explosive,' could not be found; according to all reports he had left the district and his whereabouts was unknown.

The general opinion was that anyone of the brands of dynamite is as safe or as dangerous as any other according to the treatment it receives with conditions under which it is used.

Our chemical examination of numerous samples confirms this view. We have obtained no evidence to show that Standard dynamite differs in any important respect from other brands.

J. T. DONALD.

Montreal, 5th March, 1909.

Peterborough, 26th November, 1909.

L. K. Jones, Esq., Secretary,
Department of Railways and Canals,
Ottawa, Ont.

Dear Sir,—I have your letter of 19th instant asking for information concerning on Order of the House (Mr. Robb), dated the 18th instant, asking for a return showing the number of fatal accidents resulting from the use of explosives in the construction of railways and other public works in Canada; and requesting that I forward you the information called for in so far as the works under my charge are concerned in order to the preparation of the above return.

During the past three years no fatal accidents have occurred on the works from the use of explosives, with the exception of the death of one man, H. Dowsley, which occurred last fall on Section 2 Ontario-Rice Lake Division, Dennon & Rogers contract, whose death may have been caused by explosives.

The facts as far as we know are as follows:—

On the 5th December, 1908, near lock-pit No. 5, foreman Godfrey and two men, R. Smith and H. Dowsley, made a small fire and were thawing out a piece of ¾-inch iron pipe which had become partially filled with earth and water, frozen solid, when the pipe exploded, seriously injuring Godfrey and the man Dowsley, the latter afterwards died in Belleville from his injuries. The men had been using the pipe for cleaning out holes drilled in the rock for blasting the same. I understand that a post-mortem examination was made when it was found that a piece of the pipe had penetrated his body. No further investigation was held as far as I know.

ALEX. J. GRANT,
Superintending Engineer.